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## Concepts in Disaster Medicine

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# Mass Decontamination of Companion Dogs in Disaster: Planning for Personnel, Water, and Time Requirements

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## Abstract

**Objective:** The importance of companion animals in the daily lives of people, and the increasing incidence and severity of natural disasters impacting people and their animals, is very well documented. However, despite the advancement of companion animal response capabilities, decontamination remains an inconsistently implemented component of disaster response. The challenge for local authorities is their need for planning factors and protocols specific to companion animal decontamination which are generally lacking. Data is provided on the average time requirements, water use and containment resources necessary, and the personnel required to decontaminate (decon) a large number of companion dogs.

**Methods:** Sixty-three lightly contaminated, medium weight, short to medium coat, highly tractable dogs (Labradors and Hounds) from a State facility colony were used to determine the water requirements, soap effectiveness, and time required to complete decon (washing/bathing). Data were collected over a 6-mo period using 2 personnel that were randomly assigned to wash the dogs. Difference in weight, bathing time, and water use between groups was evaluated using a 2-tailed 2-sample t-test for independent data.

**Results:** The time and water requirements were significantly different between medium coated dogs and short coated dogs. On average, for a short coated dog, the amount of time to complete decon was 7 min, and the amount of water was 8-10 gal. For medium coated dogs, the time increased to 10-12 min to complete the process and 12-15 gal water.

**Discussion:** The results of this study provide important insights emergency management planners, animal response team members, and community personnel tasked with implementation of mass decontamination of companion dogs following a natural or man-made disaster.

The importance of companion animals in the daily lives of people, along with the increasing incidence and severity of natural and man-made disasters impacting ever expanding numbers of people (and their animals) is very well documented.[1–6] The increasing frequency and severity of natural disasters in the United States and elsewhere has led to awareness of the critical need for robust planning efforts and deployment of trained personnel to assist in disaster response on behalf of people and animals.[7–11] However, 1 aspect of emergency planning and response that has lagged, despite its importance for human and animal health and safety, is the consistent implementation of decontamination of companion animals (dogs, cats, and small exotic pets) following a disaster.[9,11,12]

Disasters result in the intentional or unintentional release of hazardous materials into the environment.[12,13] Hazardous materials (hazmat) are not only a by-product of industrial or chemical, or other man-made, accidents but are represented by a wide diversity of Chemical, Biological, Radiological, Nuclear, and Explosive materials, also known as CBRNE, and are present to varying degrees in all natural and man-made disasters.[12,13] The World Trade Center terrorist attack and resulting collapse of the structures resulted in a toxic combination of jet fuel, burning building materials including asbestos, polycyclic aromatic hydrocarbons, metal compounds, dioxins, and volatile organic compounds liberated in the wreckage, that all first responders were exposed to, and many suffered with severe illness or died due to their exposure.[14,15] Hurricanes and other floodwater events are also well known to contain toxic materials that have been collected from the effluent of households and affected businesses or industries as well as raw sewage.[16,17] The exposure and risks to community members, disaster victims and evacuees (including animals) in natural disasters of all types points to the consistent need for the inclusion of decontamination procedures in all disaster response.

Decontamination is the process of removing contaminants from people, animals, equipment, structures, and the environment.[18] Decontamination protocols are devised to eliminate exposures to hazmat and to reduce the environmental spread or internalization of contamination. Many different types of decontamination products are used in humans, both for surface decon of protective suits or equipment, but also for direct application to skin to bind, alter or remove chemicals.[18–20] Most of these approaches cannot be safely used on animals due to the significant risk of ingestion (mucous membrane exposure, grooming, inhalation) of the products used (sodium hypochlorite or other anti-infectives, Reactive Skin Decontamination Lotion [RSDL], etc) – either during application process or from exposure to the material on their skin/coats during the "dwelling" time (10-30 min) required for effect.[19,20] Thus, decontamination of animals is a process that requires the physical removal of the contaminates, either by means of wiping of dry particulates or aerosols from the coat surface, or wet decon (eg, bathing) with application of emulsifying soaps and gentle working of lather into coat to remove the materials trapped on the fur and oils of the skin.[20–23]

The data available for understanding the best processes and procedures for decontaminating dogs have been derived from studies of working canines.[22,23] However, decontamination of companion animals presents a much different and far more complex challenge for emergency planners and animal responders. Some of these challenges include: (1) the sheer numbers of companion animals needing decon in a disaster will far exceed the typical working canine event for decon capacity (eg, 15-20 working dogs/d vs >100 companion dogs or more/d). (2) The haircoat (thickness, length of hair, hair type) and body size differences of the many different types of companion dogs (eg, ranges from 2 kg up to 70 kg body weight) create significant challenges in resource planning. (3) Companion dogs will present with a much larger variety of temperaments and handling tractability compared with well-trained working dogs. These variations will increase the physical time and water requirements, but also the functional requirements for animal handling expertise and veterinary medical support of the process. This study reports the first series of data needed for the creation of protocols and development of the necessary resources, including the baseline water use, and time, and personnel required, for the implementation of decontamination of companion dogs following a disaster event. In addition, protocols developed and used by our team during disaster deployments, and from several decon studies including this one, are provided to assist in the development of SOPs for all groups or jurisdictions preparing for the likelihood that companion animal decon will be needed in the future.

## Methods

### Animals

A total of 75 dogs from a colony of canines housed at a State facility were identified for inclusion in the study to develop a simple, repeatable procedure, and determine time and water requirements in decontamination of dogs. The dogs were all housed in concrete runs with indoor and outdoor sections, all were fed the same rations, and were exercised outside of their run spaces in similar locations and for similar times. The dogs are all weighed weekly to assess needs to adjust feed intake, so body weights were obtained from those data. The dogs chosen to be included in the study were 1 of 2 coat types: (1) Labrador Retrievers (medium coat) or (2) American Coonhounds or mixed breed of hound type (short coat). Additional criteria for dogs to be included in the study: all dogs were between 1 and 4 y of age and in visually good health, weighed between 20 and 35 kg, and were equally distributed by gender. Any dogs with illnesses (coughing, diarrhea, or other health issues) or dogs with skin diseases requiring treatment (topical or oral treatment) or affecting more than a localized small area of the coat were excluded from the bathing study. Dogs with mild or focal hair loss, skin irritation or presence of a small (<1/2 cm) wound were included in the study, but the presence of these issues noted. All decon procedures were performed during times when ambient temperatures were greater than 75°F (24°C). The study was approved by the Texas A&M University Animal Use and Care Committee under AUP #. 2019-0269.

### Experimental Design and Procedures

#### Decon equipment and set up

All dogs were bathed by 1 of 2 individuals (workers at facility*) who received just-in-time training for the decon bath procedures. The bathing procedures were observed by a single person and questions or concerns about procedures or dogs were handled by the staff veterinarian. The decon stations were set up and situated in the facility to roughly reflect the same type of set up and location (near water outlets, good drainage) that may be used by local jurisdictions near shelter locations or temporary animal shelter facilities (eg, fairgrounds, warehouses, etc). Figures 1, 2, and 3 illustrate the tub set-up used in these experiments (with the exception that the tent structure (Figure 3) was not used for these experiments. A random numbers generator was used to determine soap used, their bathing order and the bather.

The Rubbermaid tubs® were previously obtained from a local feedstore/farm supply store (one 50-gal-deep water trough, one 15-gal-feed trough) (Figures 1, 2). Holes were drilled in the bottom of the shallow (15 gal) feed trough to allow water to easily drain through (no standing water in the bottom of the tub during washing) to the collection area in the large trough (Figure 2); however, the holes were no larger than 1 cm in diameter to prevent toe or toenail entrapment. All water collected in the bottom was drained out through garden hose attached to the exit drain hole on the bottom of the water trough. The hose attachment prevents decon personnel from standing in water as it drains, but also provides a mechanism for the effluent/brown or contaminated water to be captured in a bladder or other collection berm if it was not deemed safe for release into the sewer drains or ground. In the case of this experiment, the water hose was allowed to drain into the sewer. A standard ¾ inch water hose with a nozzle sprayer attached was used for delivery of water for the decon procedures (Figure 1). A digital in-line water meter (Fill-Rite 900D digital flow meter, Tuthill Corp, Lenexa, KS) was attached to the hose near the water on/off spigot for collection of water use data. A standard stopwatch was used to measure the time to decon procedure completion. All measurements were recorded by the observer.

Glo-Germ® (Moab, UT) an oil-based lotion frequently used in veterinary and medical schools to test surgical scrub technique and effectiveness of doffing/donning protocols for assessment of trainees, was applied to the dogs as the test contaminant. This lotion is not visible to the human eye once applied and absorbed onto the coat or skin but is visible to detection by an ultraviolet

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**Figure 1.** Rubber Decon Tub Set-up.
Rubbermaid® tubs (small inside of large) set up for decon procedures. The larger 50 gal tub is the base which elevates the dog and collects water, and the smaller 15 gal tub sets inside to serve as the standing area, which is outfitted by drilling 1 cm holes in the bottom for drainage to prevent the dog from standing in wastewater. The tubs are strong and stable when placed on a flat surface. A water hose can be connected to the drain in the larger bottom tub to drain water away from the tub into a drain, bladder or other collection device as needed. Also note, that the tubs can be placed on plastic stabilizers if needed for greater elevation or to allow better drainage of the bottom tub.

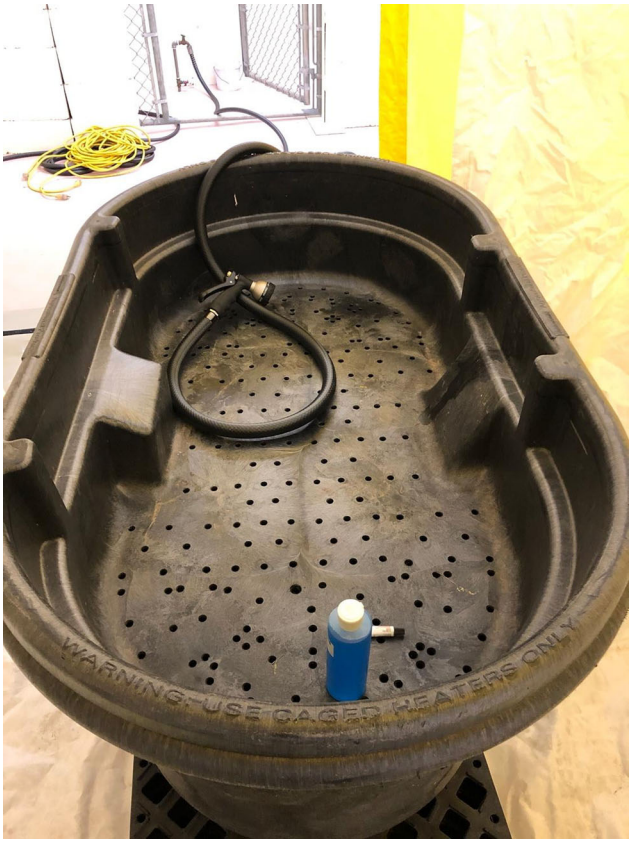


**Figure 2.** Close up of Decon Tub System.
Close up view of bottom of upper (small) tub showing holes for draining water, and illustrating the depth of the tub sides, which tend to provide a barrier for dogs to reduce the tendency to want to jump out.

(UV) light source. To simulate the presence of oil-based (the most common) contaminates on the skin and coat of the dogs, Glo-Germ® lotion was applied by the observer in 5 standard locations on each dog before it entered the bathing area: (1) under the head/neck junction (near the throat), (2) on the area in between the shoulder blades (topline), (3) on the area above the tail head, (4) inside the right front leg near the elbow, and (5) between the toes of the right rear paw (between digits 2 and 3) (Figure 4). These locations were selected based on a previous study that evaluated the most common locations for contaminants to be left on working dogs after bathing.[24] An Ultraviolet (UV) flashlight (Ultrafire® UV 395-405 nm LED light, Piscataway, NJ) was used for detection of remnant Glo-Germ® contamination after completion of the bathing procedures. If any Glo-Germ was detected, that section of the dog was re-bathed.

Two soaps commonly used in decon were chosen for comparisons of effectiveness of contaminant removal, and any difference in time or water use for completion of decon. One soap (Soap A) selected was a standard soap used in decontamination of dogs in a disaster environment: liquid dish soap (Dawn® P&G, Cincinnati, OH) due to its miscibility, safety, ease of use, and ready availability. The second soap selected (Soap B), is a common antibacterial soap used in veterinary practice (Command® antibacterial shampoo, VetriMAX Veterinary, US) was chosen as many decontamination situations involve skin exposure or contamination with sewage or other microbial pathogens. In previous studies using other antibacterial soaps, which generally do not "suds" well and, thus, could potentially be less effective in removing oily contaminants, there was greater interest in the antibacterial properties. Soap B was selected for this study because it is a new soap promoted to be both an effective cleanser and to have antibacterial properties. For purposes of this study, the antibacterial properties of the soap were not tested—only its

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**Figure 3.** Example of Decon Tub System and Tent (barrier) set up.
Tent set up with tubs is used to prevent contamination of nearby personnel or structures from wash spray or canine shaking. In this picture, an actual tent was used, but if necessary, tarps or plastic sheeting or other material could be used to provide protection from wash spray and shaking from the process.

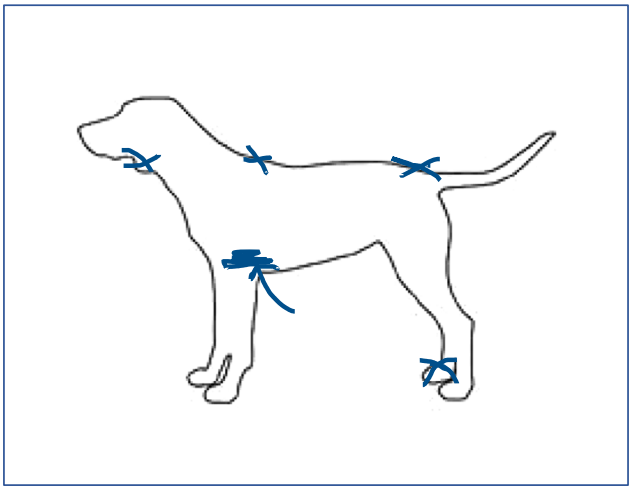

**Figure 4.** Diagram of Canine Glo-Germ Application Locations.
The locations with an "x" represent the areas on the skin where glo-germ was applied prior to the decon procedure. The area represented on the front leg is intended to represent an area inside the right front leg in the "arm pit". The locations represented are: under the chin (throat area), over the shoulders in between the shoulder blades, skin area just in front of the base of the tail, in between the toes of the right rear leg, and inside the right arm/elbow.

cleansing and effectiveness in removal of an oily contaminant. Soap A and Soap B were partialized out of their original containers into prelabeled plastic bottles (labeled only as A or B) and each bottle containing 1 oz of soap for use in the bathing process.

### *Decontamination Procedures*

The full protocol for the decon procedures is described in Table 1 and equipment used for the process is listed in Table 3. Briefly, the wash area and each dog was prepared for the decon process by the observer with the following steps performed before each procedure: the Glo-Germ® was applied with a gloved hand as described and allowed to dry for 5 min, the water meter was attached to the hose and tested for function and set to 0, the stopwatch/timer was checked for working order and set to 0, and the bathing area and tubs were assessed to be free of any hair, water, soap, or other debris that could interfere with the process or outcome. The observer and bather assessed each dog before starting decon to be sure they were apparently healthy and had no obvious hair loss or skin redness that would cause them to be removed from the process. The dog was placed in the decon unit by the bather who was wearing a water protection apron, but not full personal protective equipment (PPE;no eye protection or boots) and nitrile gloves were worn during application of Glo-Germ® and during initial sudsing. The water meter and stopwatch timer were started as the process to wet the dog was started. The bathing procedures were as follows: (1) the dog was wetted from head to tail, top to bottom; (2) Soap A or B was applied along the top line of the dog (the maximum amount was 1 oz, but in some dogs less than 1 oz was used) and the washer used their hands to work the soap into the coat of the dog—from front to tail, top to bottom on 1 side, then the other side; (3) once the dog was well lathered, the rinsing process began—again head to tail, top to bottom—1 side then the other, until all of the visible soap was removed – including from the feet. At completion of the rinsing procedure the lights were dimmed to allow a black light (UV flashlight) to be used to assess for any remaining Glo-Germ®. If none was found on the dog (particularly checking the 5 locations), the water meter and timer were stopped, and numbers recorded. If any residual GloGerm® was present the washing procedure resumed until the UV test was negative. All data was recorded by the observer immediately after the process was deemed completed and the dog was returned to their kennel.

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**Table 1.** Protocol for Decontamination of Companion Dogs

**A. Pre-Decontamination Tasks (1 person)**

1. Make sure that decon area is completely set up with equipment, supplies for decon and personnel and containment (Table 3).
2. Medical assessment by veterinary personnel is essential to assure that canine is medically stable enough for decon or if needed provide appropriate medical care or preparation (sedation?) as needed to complete process safely.
3. Fill out Work Sheet or record for each dog with appropriate information about the dog (name, handler/owner, age, breed, sex, and any medical issues).
4. Assure all personnel are at station and in appropriate PPE as required: 1 person/vet for assessment/prep, 1 person to hold, 1-2 persons to bathe (decon), and 1 person to remove clean dog to drying area or kennel / shelter area.

**B. Decontamination Procedures (1-2 persons)**

1. Remove all apparel (collar, harness, leashes, etc) and restrain with a slip lead that can be washed or disposed as required.
2. If dry particulates (not wet or oily!) are present on the coat, wipe the coat gently (front to back, top to bottom) with a damp microfiber cloth to remove the largest particulates before wetting the coat. Do not vacuum or brush or sweep with force – these techniques will push materials deeper and can be harmful.
3. Rinse eyes and nose with sterile saline, then apply eye lubricant (paralube or other sterile eye lube) to both eyes to protect from soap.
4. A muzzle should be placed on all canines (regardless of demeanor for safety of all and the prevention of inadvertent injury) after face is wiped and muzzle is placed.
5. Place dog in/on the elevated tub surface – the elevated surface helps to prevent excessive bending over during the washing process and the surface has multiple small drainage holes in the bottom that are there to prevent the canine from standing in contaminated bath water (Figure 1, 3).
6. Wet dog from head to tail, top to bottom, making sure entire coat is wetted. In long coated dogs this may take a bit longer, but soap action will be incomplete if coat is not thoroughly wetted.
7. Apply small amounts of dish soap to top of head, back, sides, rear, undersides and feet – the amount of soap used for each dog will vary, but Dawn® or other dish soaps tend to lather well, so less is more. The key to effective removal of contaminants and hazardous material is work the soap down to the skin (dogs with short coats will be easier than dogs with thick undercoats or longer hair). Use your hands (not a brush) to lather the soap from head to tail, top to bottom. Stiff brushes or mitts will potentially cause skin abrasions and increase contaminate exposure or uptake.
8. Rinse dog completely in the same manner – head to tail, top to bottom, each side and the undersides, and eventually feet – to be sure all soap is removed from the coat and as the last step before removing the dog from the wash area, pick up and rinse each foot individually and carefully.

**C. Post Decontamination Procedures (1 person)**

1. Remove the dog from the wash area and towel dry. Remove muzzle and place clean leash on dog to remove from wash area.
2. If temperatures are less than 70F, place in kennel in warm area for drying or add kennel dryer.
3. Check to be sure everything that must be recorded has been written into the sheet before starting the next dog.
4. Any hair or other debris remaining in the tub area should be removed prior to starting the next dog – to prevent drain clogging or cross contamination of animals in the clean area.

**Table 2.** Summary table of data for time, water, and bathers

| | Mean | SD | *P*-value |
|---|---|---|---|
| **All Dogs ($n = 63$)** | | | |
| Weight (medium coat) | 27.4 kg | 5.5 kg | $P < 0.0001$ |
| Weight (short coat) | 22.2 kg | 3.5 kg | |
| Wash time (medium coat) | 535.9 sec | 238.9 sec | $P < 0.0001$ |
| Wash time (short coat) | 368.5 sec | 119.3 sec | |
| Water use (medium coat) | 7.91 gal | 1.99 gal | $P = 0.003$ |
| Water use (short coat) | 6.33 gal | 2.02 gal | |
| **Medium coated dogs: Bather 1 ($n = 8$), Bather 2 ($n = 28$)** | | | |
| Bather 1 (wash time) | 401 sec | 107 sec | $P = 0.001$ |
| Bather 2 (wash time) | 574 sec | 132 sec | |
| Bather 1 (water use) | 6.43 gal | 1.30 gal | $P = 0.0154$ |
| Bather 2 (water use) | 8.33 gal | 1.97 gal | |
| Soap A (wash time) | 545.3 sec | 163.5 | $P = 0.6551$ |
| Soap B (wash time) | 524.1 sec | 104.3 | |
| Soap A (water use) | 8.11 gal | 2.23 gal | $P = 0.5122$ |
| Soap B (water use) | 7.66 gal | 1.69 gal | |
| **Short coated dogs: Bather 1 ($n = 21$), Bather 2 ($n = 6$)** | | | |
| Bather 1 (wash time) | 336 sec | 106 sec | $P = 0.0066$ |
| Bather 2 (wash time) | 401 sec | 41 sec | |
| Bather 1 (water use) | 6.21 gal | 1.92 gal | $P = 0.5687$ |
| Bather 2 (water use) | 6.76 gal | 2.49 gal | |
| Soap A (wash time) | 351.2 sec | 137.5 sec | $P = 0.4797$ |
| Soap B (wash time) | 384.5 sec | 102.0 sec | |
| Soap A (water use) | 5.88 gal | 2.10 gal | $P = 0.2676$ |
| Soap B (water use) | 6.76 gal | 1.92 gal | |

SD = standard deviation; kg = kilograms; sec = seconds; gal = gallons.
Summary of dog weights, wash time, and water usage for medium coated ($n = 36$) and short coated ($n = 27$) dogs washed by two bathers using two different soaps.

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**Table 3.** Decon equipment and supplies

Equipment - General

Container / area for decon equipment storage
- Pack the decon kit smaller items in one box
- The larger items (pools, tents, tarps and tubs) are separate but in the same area
- Waterproof tarp or preferably a tent (shade and prevent water spray) and berm (to collect water)
- The tarps can be used in place of tent as walls to contain water spray from contamination of the surrounding area or can be used as floor protection if berms not available

Supplies for Decon Kit

1. Sealable industrial strength plastic (trash) bags
2. Hose
3. Spray nozzle or wand
   - This allows for water to be better directed underneath the canine (belly wash)
   - An adjustable water flow (control water use and more gentle spray)
4. Buckets
   - Used to throw in the contaminated collars, leashes, and used brushes until they can be collected in bags for disposal or cleaning
5. Water heater (propane or other water heater if temp is less than 72F)
   - A tent or other indoor/protected environment that can be warmed is needed to prevent hypothermia
   - Groomers drying unit to if heater unavailable
6. Pools – Can be used in place of a hazmat berm if not available
   - A WMD or HazMat decon model uses two separate areas: one for wash station and another for the rinse station, this is ideal but increases personnel and equipment requirements
7. Elevated Wash Areas – can be tubs with holes to drain or plastic shelving (Fig 2)
   - Advantages include keeping the canine out of contaminated water, preventing them from drinking that water, easier to decon properly (especially under the belly and the paws), easier on your back, and easy to assemble and store
   - Plastic shelving or stands are inexpensive, light-weight, and easily assembled but will probably not stand up to intensive use over a deployment with daily use – also must be careful with size of holes in plastic as can get toes caught in them.
8. Shallow Pan or container
   - Can use for foot bath or to hold brushes/equipment for cleaning

Equipment – Human PPE -level of PPE should be directed by hazmat personnel if possible.

1. Eye/face protection
   - 4-8 pairs eye protection glasses (prevent eye contamination from spray)
   - Mask (surgical or N95) recommended to prevent wash spray from entering mouth/nose
   - Safety glasses with a face shield also is an option
   - Full face/respiratory protection (1/2 or full face respirator) if hazmat recommends
2. Gloves – Multiple size (XS, S, M, L, XL)
   - Nitrile gloves (no latex)
   - A heavier over-glove if needed for protection from more hazardous materials
   - Will need multiple boxes of each size to accommodate changes, tears, etc.
3. Tyvek suits or situation-appropriate protective suit – at minimum use apron or rain suit or water repellent removable gown to protect clothes from water spray
4. Boots
   a. Rubber or chemical resistant boots ideal, but can use boot covers – shoes must be water resistant and heavy duty to prevent contamination.

Decontamination Supplies (at pre-decon station)

1. Mineral Oil – 1-2 bottles
   - Use smaller bottles for easy application to areas of petroleum-based contamination (usually on the paws and in between the toes) – will increase removal of oily contaminates
2. Eye/Nose Rinse – 4 bottles (to rinse nose/eyes before placing muzzle)
   - There are saline and purified water solutions (contact lens solutions) that can be purchased off the shelf
   - Alternative is sterile saline wound irrigation solution and apply with a syringe
3. Eye lube (veterinary) or sterile petrolatum
   - Eye protection from soap
4. Muzzles (various sizes of cloth muzzles and some cage muzzles)
   - ALL dogs, even very calm, tractable dogs should be muzzled for personal safety
   - If dog is not handleable or still reactive with muzzle on, the dog should not be decontaminated without veterinary supervision or sedation for safety reasons
5. Leashes (Disposable slip leashes)
   - Necessary to control dogs once the collar and leash removed
6. Liquid soap
   - Dish detergents like Dawn® or Palmolive® are traditionally used in animal decontamination, alternative Prell®
   - Oatmeal based (non-medicated) dog shampoo good to have for dogs with skin issues
7. Surgical scrub brushes (soft brush important! – stiff brushes can cause skin irritation and increase exposure to contaminates)
   - The BD E-Z Scrub 160 Ref 1603 (2 boxes, 30/box) have a plastic bristle side and a sponge side
8. Microfiber towels
   - Moisten and can use to remove dry particulates before wet decon – helps reduce pushing particulates like insulation or other building materials deeper into coat
9. Large absorbent towels
   - Drying dog after decon
   - Emergency blankets for wet cold
10. Scissors (removal of mats, etc)
    - Bandage scissors are preferred as they have a blunted tip that won't cut the skin when taking off bandages or matted hair
    - Never shave or use clippers to remove hair to skin level, as this may cause abrasions and worsen contamination, and will take a significant amount of time

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### Statistics

Continuous variables were presented as mean ± standard deviation, with normality of data assessed by observing histograms. Summary statistics were used to describe dog weight, bathing time, and water use stratified by hair length (short vs medium), with additional stratification by shampoo product (A vs B), skin health (normal vs mildly irritated), and bather (1 vs 2). Difference in weight, bathing time, and water use between groups was evaluated using a 2-tailed 2-sample t-test for independent data. Evaluation of linear trend in continuous data was assessed using the least squares method. A $P$-value < 0.05 was considered statistically significant. Data analysis was conducted using Stata IC 15 (StataCorp LLC, College Station, TX).

## Results

The dogs used in this decontamination study were used to handling, behaviorally stable, of similar housing conditions and ages, and were of relatively similar sizes to create a data set of minimum standards for water use, time required, and personnel for decon of generally lightly contaminated dogs. The dogs were of 2 different hair coat types: short coated (American Coonhounds and hound mixes), and medium hair coats (Labrador retrievers). Initially, 75 dogs were selected for inclusion, but ultimately only 63 dogs completed the project due to exclusion for skin conditions or other health concerns. Of the total number washed, there were 36 dogs with medium hair (Labradors or mixed breed dogs), and 27 dogs with short coats (American Coonhounds, hound mixes). The dogs with medium hair coats were heavier, mean 27.4 ± 5.5 kg (60.2 ± 12.2 lb), than dogs with short coats mean 22.2 kg ± 3.5 (48.9 ± 7.6 lb) ($P < 0.0001$), but body weight ultimately was not a good predictor of bathing time for either short coated dogs ($R^2 = 0.2043$) or medium coated dogs ($R^2 = 0.1234$). However, coat length did impact washing time, as dogs with medium coats took significantly longer (535.86 ± 238.9 s or 8.9 ± 4.0 min) to wash than dogs with short hair (368.48 ± 119.3 s or 6.1 ± 1.99 min) ($P < 0.0001$) (Table 2).

There were 2 bathers for the study who were given just-in-time training immediately before the start of the study. There were significant differences found between the bathers throughout the study, with bather 1 having significantly shorter wash times than bather 2 for both the short coated dogs ($P = 0.0066$) and the medium coated dogs ($P = 0.001$). However, the distribution of dogs between the bathers was not equal (even though dogs were randomly assigned), with bather 1 washing a significantly larger number of short coated dogs ($n = 21/27$) compared with bather 2 who washed a larger number of the medium coated dogs ($n = 28/36$) (Table 2). The impact of this difference on the times is unknown. There was not a significant difference between bathers for bathing effectiveness (only 2 dogs for each bather had to be re-bathed due to presence of Glo-germ detected after the bath ($P = 0.5297$). However, when Glo-Germ was detected, the throat latch and between the toes were the 2 locations in the dogs where it remained.

In this study, the body weight of the dog was not a good predictor of water use needs for either the short coated dogs ($R^2 = 0.1471$) or medium coated dogs ($R^2 = 0.2865$). However, while the weight of the dog was not a good predictor of water use, the coat length of the dog was a significant factor. Dogs with medium coat lengths required significantly more water 7.99 ± 1.9 gal water than the dogs with short coats (6.33 ± 2.02 gal) ($P = 0.003$) (Table 2). There was no effect on the water use detected for either type of shampoo (soap A vs B) for either coat length ($P = 0.2676$), nor was there an effect of time for either type of shampoo (soap A or B) ($P = 0.4797$). There was not a significant difference in water use detected between bathers for the dogs with short hair ($P = 0.5687$); however, for the medium coated dogs, bather 2 used significantly more water (8.33 ± 1.97 gal) than bather 1 (6.43 ± 1.30 gal) ($P = 0.0134$). However, as noted previously, bather 1 washed significantly fewer medium coated dogs than bather 2.

## Discussion

Disasters affecting large populations and impacting significant property and commercial interests are becoming an increasing common occurrence.[1–4] And, as has been well documented when people are impacted by disaster, so are large numbers of animals.[2–6] Decon of companion dogs impacted by a disaster is important not just for their health but is also critical to prevention of secondary human exposures to hazardous contaminates on their feet and coat surface.

Planning for and implementing mass decon for large numbers of companion animals is complicated by multiple factors that are not a concern for human decon processes (inability to remove clothing; hair that may be matted, thick, or double coated' behavior' etc). While this study only focuses on a small subset of companion animals (medium sized companion dogs), the data on time, water use, and personnel needed provide a critical baseline for developing the processes and procedures necessary to plan for and implement companion animal decon.

The time required to decon lightly contaminated, medium weight, short to medium coat, highly tractable dogs provides a baseline of time data for understanding how many dogs can be decontaminated in a typical work shift given the needed personnel to complete the process.

Clearly, small dogs with very short hair (eg, dachshunds or Jack Russell terriers), large dogs with dense coats (German Shepherds or Huskies), dogs with long, easily tangled coats (Afghan hounds, etc) or dogs with mud- or oily contaminated covered coats will not fit these data, but adjustments can be made to adapt the planning process accordingly. Given the average wash time of 8-12 minutes/dog in this study, the minimum total time will be 15-20 min when counting the prewash preparation and postwash processes (Table 1). To illustrate for planning purposes, to decontaminate 50 rescued dogs with only 1 decon line available, and estimating 3-4 dogs/hr capacity, the average time required to complete the process is 12-15 hr to decon this number of dogs. This is not impossible, but if the number of dogs was not 50 total dogs, but 50 dogs/d—a number possible in a large-scale disaster, and 1 similar to several deployments experienced by this author, the situation would create an extremely difficult, if not impossible, physical task for personnel in 1 decon line operating over multiple hours or days. A potential limitation of this study was the fact that the bathers were not wearing full PPE throughout the study. Requiring the bathers to wear full PPE may have slowed/changed the bathing time or altered the effectiveness of bathing (although in the authors experience, bathing with nitrile exam gloves does not impact effectiveness) – but for this study, to reduce the over time requirement for the bathers to complete the study, and reduce costs for PPE, this aspect of process was modified. Furthermore, if the situation demanded (due to hazmat risk to personnel) wearing of higher level PPE (eg, Tyvek or respiratory protection, etc) than

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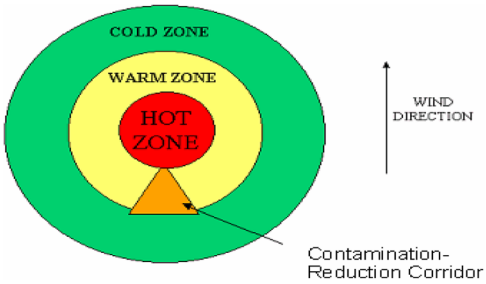


**Figure 5.** Decon Working Zones and Personnel.
**Pre-decontamination area**: in the edge of the "hot" or contaminated zone – here personnel must wear PPE. Personnel needs: 1 trained vet tech (or veterinarian) for assessment of the health and behavior of the dog, and area to remove collars/leashes, etc, wash face/eyes, and place muzzle.
**Decontamination area:** in the contamination reduction ("warm") corridor/area. Personnel must wear PPE. Personnel needs: 2 personnel trained to handle and wash dogs.
**Post-decontamination area:** in the "cold" or non-contamination / clean zone. Personnel are not required to wear PPE. Personnel needs: 1 person to transport dog to kennel or drying area.

the standard decon protective gear (water barrier apron or suit, eye/face protection, and gloves), the amount of time that individuals could safely work in the decon line would be significantly reduced.[13,25,26]

The water requirements for decon are an important planning factor primarily under the conditions of needing to provide water (ie, city water contaminated) or when the gray water (wastewater) from the decon process must be captured rather than released into the sewer drain or ground. The amount of water required for decon of dogs used in this study is considered as a minimum requirement, as the water use was tightly controlled (water sprayer that did not leak, water turned off between dogs, etc), and the dogs used were very used to bathing, and were short/medium coated dogs with light contamination. Using the previous example, if a jurisdiction had 50 companion dogs to decon, the amount of water to be used and collected (10-12 gal/dog volume), would be approximately 500-600 gal. Water tanker trucks have variable capacity (typically 500-5000 gal), but in a disaster the water needs for multiple aspects of the impacted community will likely impact the availability of this resource and must be included in pre-disaster planning as a consideration. Water capture and containment for hazardous materials (eg, bladders or tanks) also come in a variety of sizes 50-10,000 gal, but will also be in high demand during a disaster response.

The personnel requirements for decontamination of animals are quite significant—not only because of the need for animal restraint, but personnel workload, rest, and PPE safety needs will require frequent rest periods for workers. This project was completed with 3 personnel/station, 1 person serving as timer/preparer, 2 handlers (1 holding and 1 washing 1 side of the dog, then reversing the roles for the other side), but it is worth noting that the dogs used in this study were dogs used to handling and bathing, which could have significantly reduced wash time. Both Table 1 and Figure 5 provide descriptions of the personnel needed in the process, and how they should be configured in the process. However, typically for companion dog decon in a disaster situation, a minimum of 4 personnel with 1 highly skilled in animal handling/care and 2-3 with just-in-time training are required for a single decon line. A veterinarian (or at minimum veterinary technician) should be included in the process to provide animal assessment (temperament, health, triage if injured) before starting the animal decon procedures. Veterinarians are particularly important in the event of need for behavioral assessment, sedation, or other medical intervention to ensure safe decon of the animal and prevention of injury to the animal or decon personnel.

The equipment required to create a decon line is readily available but some prior preparation is ideal for the best outcome. Table 3 provides a comprehensive list of the equipment, supplies, and decon procedure needs for creating a decon station/line. In most emergency animal decon, the decon line is set up near the emergency animal shelter location, close to an area with water access—which may or may not be an ideal location for water containment or animal processing. No matter what location is selected, steps must be taken to mitigate contamination of the area and nearby people, by using tarps or tents to cover the decon site and a berm to collect wastewater (Figure 3). Ideally, the decon washing station itself should be elevated (Figure 1), to prevent excessive bending over during the washing process. An elevated station will also assist personnel in proper restraint of the dog. For this study the Rubbermaid® tub system that was previously and frequently used in our emergency response cache, was used to decon all dogs. The tub system was originally selected for its stability and simplicity, but the ready availability and relatively low cost (eg, can be purchased from local sources) of the tub system makes it an ideal option for local jurisdictions and groups needing to create an elevated, stable, and readily available, and relatively inexpensive station for decon of a large number of companion dogs.

Finally, a debate exists about the use of owners to decon/wash their own dogs as they both enter and traverse the human decon stations set up for mass decon of people following a hazmat event or disaster. The circumstance where the human and its canine should be decon'd together are basically twofold: post-work decon of a working canine, which will absolutely require the the dog's handler for the safety and effectiveness of the process, or a service canine (eg, seeing eye dog, hearing assistance dog or medical alert dog, etc) where separation of the dog from his medically dependent human would be dangerous. For all other scenarios, in the experience of the author in multiple situations where the author has served as observer for a dual exercise of human/animal decon processes, the attempt to combine human and canine decon resulted in a significant slowing of the human decon process. Furthermore, the behavioral issues that were frequently observed in the dogs in the hectic environment (fear, resistance to handling/bathing) also created poor bathing effectiveness, all of which made the decon ineffective and slow.

In summary, the data collected from these experimental trials and practical experience gained from disaster animal decon experience provide emergency planners and personnel responsible for providing animal decon with both procedural and planning guidance for 1 of the most complicated disaster response challenges: companion dog decontamination. The development of these procedures is an important first step, as decon of companion dogs is a very time intense, personnel intense, and animal expertise intense process. Future work is needed to create the necessary guidance for decon of other companion animals, such as cats, birds, and exotic or pocket pets (eg, rabbits, hampsters, etc) that are impacted by disasters and may require decon. Nevertheless, the starting point for any disaster plan is to create the roadmap, so that the tools and personnel needed can be identified and assembled before the time they are needed and then the process should be exercised. This study provides that basic processes and procedures, along with the time, water, and personnel requirements that will

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assist in emergency planning and implementation of this essential disaster response function.

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